LAKE STATES ASPEN REPORT NO. 16

ASPEN FOR EXCELSIOR

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FOREWORD

During and since World War II, there has been increasing interest in aspen (Populus tremuloides) in the Lake States, its availability and supply, properties and uses, and management. Aspen is a tree of primary importance in 20 million acres or 40 percent of the total forest area of the three Lake States - Michigan, Minnesota, and Wisconsin.

At an informal meeting at Madison, Wisconsin, in January, 1947, forestry representatives of several federal, state, and industrial groups in the Lake States agreed that it would be desirable to bring up to date what is known on aspen and make it available to anyone interested. The job of preparing this information in the form of reports was assigned to each of the groups listed below. The reports will be duplicated as rapidly as completed, and the entire project should be finished by the end of 1947. Each report will concern one aspect of the subject. Copies will be available from the Lake States Forest Experiment Station or from each contributor.

Report Number	Subject
1	Aspen Properties and Uses
2	Aspen Availability and Supply
3	Logging Methods and Peeling of Aspen
4	Milling of Aspen into Lumber
5	Seasoning of Aspen
6	Aspen Lumber Grades and Characteristics
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16	Aspen for Excelsior
17	Aspen Defiberization and Refining of Product
18	Chemical Utilization of Aspen
19	Preservative Treatment of Aspen
20	Marketing of Aspen
21	Possibilities of Managing Aspen

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REPORT NO. 16

ASPEN FOR EXCELSIOR

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The use of aspen for the manufacture of excelsior is well established in the Lake States. The properties of the wood make it suitable for this general use, and there are adequate supplies available for increased productive capacity. The process of manufacturing excelsior is relatively uncomplicated, and the production equipment is simple and relatively low in cost. That the industry is not more extensive is obviously due to limitations in markets for excelsior. Expansion of the industry depends primarily upon the development of new uses and new products having excelsior as a base.

HISTORY OF THE INDUSTRY

Excelsior manufacture has been characterized by shifts in species and major markets and a reduction in volume produced since its original development in this country in 1860 (2).

Basswood was the original favored species. Later aspen and cottonwood became the leading excelsior woods. These species are closely related and both have properties similar to basswood and have long been more economically available. In areas where these species are scarce, pine has become an acceptable excelsior wood and is even preferred for some product uses

Excelsior was originally used mainly for mattress stuffing. As more satisfactory materials were developed and designs were improved, this market for excelsior was reduced to only the less expensive mattresses. Upholstery was once a major use for excelsior, but the amounts absorbed by this market have declined as preference has shifted to more satisfactory materials. Packing for fragile merchandise has been the major use for excelsior for many years. In recent years, competing packing materials, which have proven either more specially suitable or cheaper, have displaced excelsior to a considerable extent. These shifts, in major uses, have caused excelsior manufacture to lag behind general business activity.

There has been a reduction both in number of plants manufacturing excelsior and in total volume produced, but the mortality of plants has been more severe than the decline in production. The larger plants, with lower costs and better marketing facilities, have tended to survive. In 1909 there were 109 excelsior plants in this country (4).

The number had been reduced to 75 in 1923 (4), and 53 in 1939 (5). In the post-war period 3 additional plants came into production.

Volume produced was nearly 190,000 tons in 1929 (3) and 123,000 tons in 1939 (5). In 1947 the production had recovered to approximately 152,000 tons (6). The recent increase has, of course, been due to improvement of general business activity. It is probable that a major portion of this increase has been in terms of a closer approach to capacity production in established plants rather than new productive capacity.

It is significant to note that while total production of excelsior increased about 24 percent, production of baled or bulk excelsior increased only about 13 percent from 1939 to 1947. Excelsior manufactured into pads and wrappers increased about 64 percent during the same period (6). Part of this increase has been due to shortages of competing materials. Except for these specialized forms of packing material, there has been very little excelsior remanufactured into products by excelsior manufacturers.

The conclusion to be drawn from the history of the industry is that the use of bulk excelsior has not kept pace with general economic development in this country. Survival of plants, in the face of shrinking markets, has apparently depended upon the ability to expand sales effort and to remanufacture the primary product for special uses.

MANUFACTURING PROCEDURE

Excelsior wood is usually purchased as peeled cordwood with a minimum diameter of about 4 inches and a maximum diameter, without splitting, of about 7 inches. The common cordwood length in the Lake States is 55 inches with squared ends.

The wood needs to be air-dried before use. This requires the manufacturer to maintain a raw material inventory equivalent to 12 to 18 months' production. Unpeeled wood begins to deteriorate before drying is completed. When it has been necessary to accept unpeeled aspen because of labor shortages in the forest, some manufacturers have resorted to mechanical peeling at the plant. Excelsior wood is usually procured from small producers through contracting agents.

The 55-inch sticks are reduced to 18-inch bolts before entering the excelsior plant.

Conventional excelsior machines are simple in principle and require little skill in operation. The cutting element is similar to that of a carpenter's hand plane with the addition of spurs to cut the "shaving" into ribbons. Adjustment of the feed and spacing of the spurs determine the size or "grade" of excelsior produced. The blade is suspended in a sliding frame that reciprocates along the axis of

the wood bolt. The bolt is gripped on each end by a fluted feed roll which advances the bolt into the blade at each pass of the frame. Although many machines in use are the single-place vertical type, the most modern model in common use has a horizontal action with places for 8 bolts. The single operator for this machine places the bolts in the feed rolls and removes the thin slab before it slivers.

From the excelsior machine, the product goes directly to the baling machine or to a remanufacturing department. In large plants the material is picked up automatically on a conveyor belt. Sometimes, before baling, the bunched excelsior is passed through shaking equipment to remove objectionable fine fibers. The baling equipment is the conventional type used for hay or straw. The bales usually weigh 100 or 200 pounds.

At plants where pads and wrappers are manufactured, the excelsior is conveyed to a department where it is stuffed into paper sleeves or bags by special machinery.

CHARACTERISTICS OF THE INDUSTRY IN THE LAKE STATES

Excelsior manufacture in the Lake States evidently accounts for somewhat more than half of the national production. In 1946 this segment of the industry received over 95,000 standard cords (9). At approximately one ton per cord this is equivalent to more than 60 percent of the total national shipments of excelsior products for 1947.

There were 7 plants active in the region in 1946, and one of these was destroyed by fire during that year. Four other plants, representing about 10 percent of the total productive capacity in the region, were reported as idle during that year (10).

It may be seen that the excelsior industry in this region is set up generally in large production units. They are large enough to maintain independent sales organizations and to develop markets. They can adapt themselves more easily to changing market conditions than can small-scale manufacturers. All of the large plants have been established for many years. One large excelsior organization in the area is engaged in the remanufacture of parts of its primary product into pads and wrappings, primarily for the furniture industry.

Several of the larger plants are located in areas which, because of local timber depletion, no longer have ready access to the more abundant sources of excelsior wood.

Two of the larger plants are located in industrial communities where wage rates are affected by higher skills than are required in excelsior manufacture.

Both aspen and basswood are acceptable for excelsior wood in the Lake States, but 94 percent of the supply used in 1946 was aspen (9). The

cost of the raw material has been affected by competition from pulp mills in the Lake States, which have been demanding aspen in increasing quantities in recent years. It has been the leading single pulpwood species cut in the Lake States for the past several years. In 1947 it amounted to more than 25 percent of pulwppd produced in the region (11). Both pulp mills and excelsior plants generally are located at a considerable rail haul distance from the major supplies of aspen.

PROPERTIES OF ASPEN

One of the principal properties that make aspen specially suited for excelsior is its fine uniform texture. This contributes to the uniformity and strength of the excelsior ribbons. Aspen is much superior in this respect to the ring-porous hardwoods and the coarse-grained softwoods which are likely to yield excelsior strands that vary in density and strength even in a single strand. Aspen excelsior may be handled or used without developing excessive broken strands. Its general straight grain contributes to the uniformity of the individual strand.

Aspen is low in density and yet tough and resilient in the form of ribbons. It fills in space firmly around fragile items without contributing greatly to the weight of the package. The massed strands of excelsior are able to maintain a spring tension against a packed article or to recover from deformation as a padding material. Aspen excelsior pads and wrappings may be twisted and bent into various shapes to conform to the parts of products that need protection in crating.

Aspen is very light in color and this is a considerable advantage in its use in excelsior for packing consumer goods. It may be colored readily for use in display packaging. Because of its lack of odor, it may be used in connection with the packing of foods that are easily tainted.

From the standpoint of excelsior manufacture, aspen is ideal because it occurs in large quantities in sizes adaptable for use in conventional machines without splitting.

USES FOR EXCELSIOR

The uses of excelsior are quite varied (8), although most of them account for only a small fraction of the total consumption, and these minor uses are constantly changing according to economic conditions and technical developments with competing materials.

There are two aspects of excelsior use. In one, it fills the requirements for a material that will fill space at the cheapest possible cost. This is the category represented by the major portion of excelsior consumption, and it is vulnerable to competition from many types of packing materials that can be produced and delivered to some consuming points at a slightly lower cost. In this use category, the

main advantage aspen has over other woods is cheapness. These uses may be satisfied more economically by other species in regions where they are available.

In another aspect of excelsior use it fills a requirement for a material designed for a specific technical function. In this category of use excelsior must compete with natural or synthetic materials which may be more costly but technically more suitable for a number of specific individual uses. In many cases competing materials may be engineered to exact use specifications. Excelsior is virtually limited to variation of species and strand size in its adaptation to specific technical uses.

Excelsior is marketed by grades which define the dimensions of the ribbon (13). There are three standard grades all having the same thickness of 1/100 inch. Fine is 1/26 inch wide, medium 1/8 inch wide, and coarse is 7/32 inch wide. Special grades may be produced in almost any size. Extra fine grades are called wood wool in this country and may be as thin as 1/500 inch and as narrow as 1/64 inch. Extra coarse grades may be 1/50 inch or more in thickness and 1/4 inch or more in width. The finer grades are more costly because excelsior machine blade speeds are constant and manufacturing rates are controlled by ribbon thickness.

The most common use for excelsior is in packing fragile items such as glassware, china, and other general merchandise by hand. It is extremely well suited for this use, being cleaner and more durable than many competing materials. Its best adaptability is in the packing of special orders by hand. Common substitute materials are straw and shredded newspaper. Superior materials have been developed for some special packing problems such as absorbent materials, for packing liquid-filled glass containers. The development of mass production manufacturing and packaging techniques has probably contributed to the decline in the use of excelsior packing. Other materials, such as corrugated board, have been more adaptable to package design for modern large scale manufacturing.

Excelsior-filled paper pads and wrappers represent a technical advancement in the industry which is evidently still developing. While bulk excelsior volume declined from 151,000 tons to 111,000 tons between 1929 and 1947, pad and wrapper manufacture increased from 32,500 tons to 41,000 tons in the same period (6). These products are used principally in the protection of furniture and other finished articles that are shipped in crates or unenclosed. Commonly, excelsior pads and wrappers are suitable for re-use in the shipment of household goods. Some pads filled with shredded paper are on the market, but unlike the excelsior product the paper sleeve needs to be heavy enough to bear all of the tearing stresses. This use for excelsior is one that is susceptible to further development through packaging engineering.

Mattress stuffing was originally a major use for excelsior, but only the most inexpensive mattresses now have any excelsior component in this country. Some crib mattresses have an inner core of fine excelsior. Other materials commonly used in low-cost mattresses are technically inferior to excelsior but appear to have greater customer acceptance.

Excelsior is still used to some extent in upholstery. It is used only as an inner component covered with padding materials of softer texture in some inexpensive lines of furniture. Excelsior evidently is deficient in durability under constant use as an upholstery padding material. Further, except for the extra fine grades, excelsior gives off a characteristic and objectionable harsh sound when compressed in use.

Excelsior seems to be most suitable in the manufacture of commodities in which permanence and durability in use is not a prime requirement. Manufacturers of toys use considerable quantities in stuffing dolls and toy animals. Some finer grades are used to a limited extent in both gas and liquid filtering, and the extra fine grades are suitable as absorbent material. In Europe, where other fibrous materials are comparatively scarce, the manufacture and use of the finer grades of excelsior is highly developed. There, refined "wood wool" is a commonly accepted substitute for absorbent cotton and gauze surgical pads.

A use for coarse excelsior, that appears to have possibilities for further development, is the manufacture of structural insulating board. Essentially, the bunched strands are bonded with an inorganic cement and formed into panels or slabs (7). The excelsior is usually impregnated with a chemical by dipping, in order to increase its fire resistance and aid the adhension of the binding material. Most often the binder is Portland cement or magnesite which is mixed with excelsior in the form of a thin slurry. After the excess slurry is drained off, the mass is placed in forms for the initial setting time under low pressure. After removal from the forming equipment, the product is usually stored in air for a curing period. The usual product is a panel from one to three inches in thickness. The mineral component coats the wood ribbons and binds them together in a porous mass as it sets.

Because of the time required for the setting of Portland cement, it is believed that board forming with this binder has so far not been successfully done as a continuous process; the panels are formed in individual molds. One European manufacturer, using magnesium oxysulphate as a binder, employs a continuous forming and heat-curing machine (1, 14).

The excelsior-type panel is unique as a building material because of its versatility. Its low density gives it excellent heat and sound insulation properties, and at the same time it is strong enough to

assume part of the load in structural design. Its rough surface provides an excellent base for stucco, plaster, or cement wearing surface and also provides excellent acoustical properties and decorative texture when used without additional surfacing. The material may be nailed and sawed with ordinary woodworking tools. Since the wood ribbons may be impregnated with fireproofing chemicals and are thoroughly coated with inorganic cement, the product has high fire resistance.

Panels of this material are suitable for use alone in interior non-bearing partitions. The thicker panels may be used as single-unit exterior walls when suitable column supports are incorporated in construction. In this case the exterior surface needs to be sealed from the weather by stucco or other suitable weatherproof material. The interior surface may be plastered directly on the panel or covered with other interior-finishing material. In the form of thick slabs this material is suitable for roof decking. Here, a topping of Portland cement is applied to the slab and conventional roofing material is applied as a weathering and waterproofing surface. The thicker slabs are suitable for floor planks to be laid directly on properly spaced joists. The wearing surface in this case is a fairly thick layer of Portland cement. The one-inch board may be used as conventional insulating board as exterior sheathing or interior panels. An interesting application is its incorporation on the inside of concrete walls by using the excelsior boards as the inner form boards.

Excelsior-based boards are in fairly common use in many European countries and there are four products of this type known to be manufactured in this country, mostly on a limited scale.

POSSIBILITIES OF EXTENDING THE USE OF ASPEN FOR EXCELSIOR

Apparently the traditional markets for excelsior have been shrinking for some time. Thus, these markets do not offer much hope for expansion in excelsior manufacturing facilities under normal operating conditions. The greatest inroads into the excelsior markets have been made by those materials which have become available at lower cost, and the only possibility of meeting this competition entails reduction of the market price of excelsior.

There are considerable possibilities for reducing raw material costs through mechanization of excelsior timber harvesting. This operation represents the dominant element in wood costs, and it is almost entirely involved with hand labor.

It is conceivable that production costs for excelsior manufacture could be generally reduced. Mechanization could be improved by adopting the most modern machines available or by the development of new excelsior machines involving less labor cost. Such new machines would

probably be adaptable only to large-scale production and development would depend upon large additional market outlets.

Some general cost reduction could be gained by locating excelsior plants as close as possible to aspen timber supplies. This would allow direct shipment of raw material from forest to plant by truck and avoid the expense of car loading and long rail hauls. Placing the plants in the forest area would also make available unskilled labor at lower cost than in urban locations.

The best possibilities of expanding excelsior production lie in the development of new markets based on new uses. Industry is becoming increasingly conscious of the necessity for package engineering. Apparently the field is wide for the adaptation of excelsior to special packing problems as opposed to its use in bulk for hand packing.

The building industry is in the mood to adopt materials that have been proven to be technically superior and more economical than conventional home-building materials. The success of the excelsior-type boards in Europe and their versatility indicate that this product has good possibilities for market development in this country.

Technical information on excelsior is extremely rare. Virtually no engineering data are available on the properties of excelsior and little is known about methods to improve these properties. It is probable that a general research program on this material would form the basis for expanded use in many phases of industry. Without a technical background, excelsior must continue to yield markets to the engineered materials of modern industry.

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